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Storage Studies on Bottle Gourd Juice Preserved with Different Chemical Additives

KEYWORDS: Antioxidant activity, Chemical additives, Bottle Gourd, Phytochemicals

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ABSTRACT *Bottle gourd (Lagenaria siceraria) also known as bottle squash is a delicious vegetable. This is capable of delivering health benefits besides fulfilling physiological needs. Steps should be taken to preserve them to make them available for consumption in off season also. The aim of the experiment was to compare the effect of different chemical additives namely Sodium benzoate, Potassium metabisulfite(KMS) and their combination, on the physicochemical and phytochemical parameters and antioxidant activity of Bottle Gourd juice. The storage was done for 6 months at room temperature and the analysis was conducted at the interval of one month. For the physicochemical parameters like TS, TSS, acidity, a very slight but non-significant change was observed. Color values (Lab), Vitamin C, total phenols and antioxidant activity changed significantly (p≤0.05). The variation was found in the color of different samples. Considering all the parameters, samples treated with potassium metabisulfite maintained the maximum nutrient stability.*

Introduction

Fruits and vegetables have had conferred on them the status of functional foods (Hasler, 1998). They seem to be capable of delivering health benefits besides fulfilling physiological needs. Routine or habitual consumption of fruits and vegetables confers significant benefits to human health (Steinmetz and Potter, 1996). Bottle gourd (Lagenaria siceraria) is one of the important vegetable crops which belong to family the Cucurbitaceae. Bottle gourd has its origin in Africa and India and is cultivated all over the world. It has high medicinal value and hence used in some Ayurvedic medicines. Bottle gourd is a good source of vitamin- B- complex and ascorbic acid. It is rich in pectin and also contains various saponins, fatty oils and alcohols. It has a cooling effect on the human body and is also useful in prevention of constipation. White pulp of bottle gourd is emetic, purgative, diuretic and antibilious. Antioxidants in vegetables play a big role in minimizing cell damage by combining with and neutralizing free radicals. Broadly antioxidants are the substances that when present at low concentrations compared to those of an oxidizable substrate significantly delays or prevent oxidation of that substrate. The oxidizable substrates include almost everything found in foods and living tissues including proteins, lipids, carbohydrates and DNA (Frei, 1994). The non- edible portions from various fruits and vegetables (mainly seeds and peels) have been shown as good sources ofantioxidants (Naik et al., 2008). Bottle gourd plant is cultivated throughout the year in different places in different seasons. Hence the supply is not uniform through the year in one particular place and steps should be taken to preserve them to make them available for consumption in off season as well. This could be achieved by extending the shelf life in fresh form or in the processed form (Deore et al., 2008). Keeping this in view, the current study was focused on assessing the effect of different preservation methods on the shelf stability of the processed juice

Materials and methods

Raw materials

The study was conducted in the Department of Food Science and Technology, Punjab Agricultural University, Ludhiana. Bottle gourd was procured from the local market.

Extraction process of bottle gourd juice

Fresh bottle gourds were washed thoroughly and cut off from the top and were not peeled. The Bottle gourd juice was extracted in a juicer extractor (Kalsi: 9001-2008). The juice was pasteurized at 83°C for 3 min and citric acid @ 0.15% was added, followed by chemical preservatives.

Dose distribution of chemical additives

Sample	Chemical additives	Dose(ppm)
T_2	Na-benzoate	3000
T_3	KMS	3000
T_4	Na-benzoate+ KMS	1500+1500

The pre-sterilized glass bottles were filled with the hot juice and corked. T_1 sample was given the pasteurization treatment followed by processing at 100°C for 20 min in boiling water bath and gradually cooled to a low temperature under running tap water. These processed juices were kept for storage at room temperature for six months.

Physico-chemical analysis

Bottle gourd juices were analysed at regular interval of one month for the parameters like Total solids, Titratable acidity using AOAC methods. TSS was taken using hand refractometer(ERMA, Japan), color using Minolta Hunter colorimeter.

Phytochemical analysis

For phytochemical parameters, Vitamin C was determined by the titrimetric method using dichlorophenol indophenol dye (Ranganna, 1986). Total phenolic content was determined by Folin-ciocalteau reagent (Singleton and Rossi, 1965). A standard curve was plotted by taking known amount of Gallic acid as reference standard and concentration was calculated from the standard curve. The % Antioxidant activity was determined by DPPH (2, 2-diphenyl-2-picrylhydrazyl) method (Brand-williams et al., 1995). Methanolic extract of sample was taken for antioxidant activity analysis and calculated according to the following formula. BHT was taken as a standard at a fixed concentration of 5mg/ml.

$$\% AA = \frac{\text{Control OD (0 min)} - \text{Sample OD (30 min)} \times 100}{\text{Control OD (0 min)}}$$

Statistical analysis

The results were evaluated by Analysis of Variance (ANOVA) and Tukey's post hoc tests using Systat statistical program version 16 (SPSS Inc., USA).

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Results and discussion

The samples were studied for the effect of different chemical additives on Physicochemical [TS, TSS, Acidity, Color (L, a, b)], Phytochemical (Ascorbic acid, Total phenols) and % antioxidant activity for the storage period of 6 months.

Effect on Total solids and TSS

TS increased non-significantly ($p \leq 0.05$) in all the juices during the storage. On the day of preparation, the amount of TS in sample T1, T2, T3, T4 were 3.67, 4.23, 3.94 and 4.01 respectively. At the end of 6 months, the TS in the samples increased to 4.37, 4.67, 4.38 and 4.46 respectively. The TSS values of samples T_1 to T_4 on day first were 3, 3.3, 3.1 and 3.3 which gradually increased to 3.5, 3.8, 3.7 and 3.7 respectively after 6 months of storage. Although TSS increased for all the samples but the changes were non-significant ($p \leq 0.05$). Similar results reported an increase in soluble content of apple pulp during storage when preserved with chemical preservatives (Kinh et al., 2001). The treatments had no significant effect ($p \leq 0.05$) on Total solids as well as TSS.

Effect on acidity

According to the results, chemical additives as well as storage has no significant effect ($p \leq 0.05$) on acidity of the bottle gourd juice. The titratable acidity of samples T_1 to T_4 found to be on day first was 0.021 0.033, 0.034 and 0.038 that gradually increased to 0.049, 0.055, 0.051 and 0.047 respectively (Table 1). An increase in titratable acidity of apple pulp was found during storage (Kinh et al., 2001). The acidity of the thermally treated sample (T_1) increased more as compared to other chemically treated samples and the change was least in T_4 sample.

Effect on Color (L a b values)

The values for color varied significantly ($p \leq 0.05$), both for storage as well as chemical treatments. On the day of preparation, the lightest sample was T_2 followed by T_1, T_4 and T_3. Similarly, at the end of 6 months, T_2 remained the lightest and T_3 was found to be darker than the other samples. In terms of greenness 'a', T_2 was found to be the greenest and retained the maximum greenness than the other 3 samples at the end of 6 months (Table 2). The b values were highest for T_4 and lowest for T_1 and results after 6 months of storage, remained the same for all the samples. On the whole, sample T_2 with Sodium benzoate retained the best color of all the 4 samples. Tomato juice with Na benzoate seems to be more stable than the other preservatives during 6 months of storage and developed lesser off color and turbidity (Hossain et al., 2011).

Effect on Vitamin C content

According to the results, chemical additives have significant effect ($p \leq 0.05$) on Vitamin C content of bottle gourd juice. Also the Vitamin C content decreased significantly ($p \leq 0.05$) during the storage. On the day of preparation, Vitamin C content in samples T_1, T_2, T_3 and T_4 was 2.88, 3.25, 3.92 and 3.65mg/100g respectively. The values came out to be lower in T_1 as heat treatment destroys Vitamin C. At the end of 6 months, the Vitamin C content reduced to 1.28, 1.98, 2.44 and 2.06 respectively (Table 3). Vitamin C is light and heat sensitive, the concentration of Vitamin C follows first order kinetics and thus storage time affects Vitamin C content (Heldman and Singh, 1981). Out of the chemically treated samples, potassium metabisulphite retained the maximum Vitamin C. The application of KMS reduces the loss of ascorbic acid during the storage of leafy vegetables (Negi and Roy, 2000).

Effect on Total Phenols

The total phenolic content in samples T_1 to T_4 on the first day was 150, 140, 200 and 154 respectively. The added chemicals preserved the phenolic content more than thermally treated sample (T_1). Both the treatments and storage affected the total phenols significantly ($p \leq 0.05$). At the end of 6 months, the Total phenolic content came out to be 56, 58, 137 and 83 respectively (Table 4). According to the findings, a decrease in total polyphenol content of tomato juices after 3, 6 and 9 months of storage were reported (Vallverdu-Queralt et al., 2011). The decrease was found to be least in sample T_3, followed by T_4 and T_2.

Effect on Antioxidant activity

According to the results, on the day of preparation, percent Antioxidant activity for samples T_1 to T_4 was found to be 69.17, 50.33, 73.76 and 64.13 respectively (Table 5). Significant ($p \leq 0.05$) decrease in antioxidant activity was found in treatments and also during storage months. At the end of 6 months, the percent antioxidant activity decreased to 59.35, 39.75, 64.45 and 52.75 percent respectively. However, the decrease was found to be least in sample T_3. It has been reported that the decrease in antioxidant activity may be linked to a decrease in total phenolic content and vitamin C during storage (Klimczak et al., 2007). According to them, antioxidant activity of orange juices decreased by 45 percent after 6 months of storage at 28°C.

Conclusion

The experiment was to compare the effect of different chemical additives on the storage stability of bottle gourd juice. In this study, it is evident that potassium metabisulphite proved to be a better preservative than Na-benzoate for the stability of physicochemical and phytochemical parameters and maintaining the antioxidant activity of the bottle gourd juice

Table 1: Effect of storage period and treatments on Titratable acidity (%) of Bottle gourd juice*

Treatments	0	1	2	3	4	5	6
T1	0.021 ^{bA}	0.024 ^{bA}	0.029 ^{abA}	0.034 ^{abA}	0.038 ^{abA}	0.041 ^{abA}	0.049 ^{aA}
T2	0.033 ^{aA}	0.036 ^{aA}	0.039 ^{aA}	0.043 ^{aA}	0.047 ^{aA}	0.052 ^{aA}	0.055 ^{aA}
T3	0.034 ^{aA}	0.036 ^{aA}	0.039 ^{aA}	0.041 ^{aA}	0.044 ^{aA}	0.048 ^{aA}	0.051 ^{aA}
T4	0.038 ^{aA}	0.038 ^{aA}	0.039 ^{aA}	0.041 ^{aA}	0.042 ^{aA}	0.045 ^{aA}	0.047 ^{aA}

Table 2: Effect of storage period and treatments on the color values (L a b) of Bottle gourd juice*

Treatments		0	1	2	3	4	5	6
L	T1	31.24 ^{aA}	31.06 ^{aA}	30.8 ^{aA}	30.44 ^{aA}	29.97 ^{aAB}	29.64 ^{aAB}	29.32 ^{aAB}
	T2	31.8 ^{aA}	31.66 ^{aA}	31.53 ^{aA}	31.35 ^{aA}	31.08 ^{aA}	30.84 ^{aA}	30.64 ^{aA}
	T3	28.5 ^{aB}	28.36 ^{aB}	28.12 ^{aB}	28.01 ^{aB}	27.89 ^{aB}	27.66 ^{aB}	27.49 ^{aB}
	T4	29.78 ^{aAB}	29.55 ^{aAB}	29.36 ^{aAB}	29.11 ^{aAB}	28.91 ^{aAB}	28.78 ^{aAB}	28.59 ^{aAB}
a	T1	-0.56 ^{dAB}	-0.54 ^{cdAB}	-0.48 ^{bcdAB}	-0.44 ^{abcdAB}	-0.36 ^{abcAB}	-0.32 ^{abAB}	-0.28 ^{aAB}
	T2	-0.64 ^{aA}	-0.61 ^{aA}	-0.58 ^{aA}	-0.53 ^{aA}	-0.46 ^{aA}	-0.41 ^{aA}	-0.34 ^{aA}
	T3	-0.39 ^{aA}	-0.36 ^{aA}	-0.31 ^{aA}	-0.27 ^{aA}	-0.22 ^{aA}	-0.17 ^{aA}	-0.13 ^{aA}
	T4	-0.43 ^{aA}	-0.39 ^{aA}	-0.34 ^{aA}	-0.29 ^{aA}	-0.24 ^{aA}	-0.2 ^{aA}	-0.17 ^{aA}
b	T1	0.25 ^{aC}	0.21 ^{aC}	0.15 ^{abC}	0.09 ^{abcC}	0.04 ^{bcC}	-0.02 ^{cC}	-0.05 ^{cC}
	T2	0.87 ^{aB}	0.84 ^{aB}	0.71 ^{abB}	0.56 ^{bcB}	0.41 ^{cdB}	0.36 ^{deB}	0.22 ^{eB}
	T3	1.09 ^{aA}	1.04 ^{abA}	0.92 ^{bcA}	0.85 ^{cA}	0.79 ^{cA}	0.61 ^{dA}	0.53 ^{dA}
	T4	1.22 ^{aA}	1.16 ^{abA}	1.05 ^{bcA}	0.94 ^{cdA}	0.87 ^{deA}	0.76 ^{efA}	0.62 ^{fA}

Table 3:Effect of storage period and treatments on Vitamin C content(mg/100g) of Bottle gourd juice*

Treatments	0	1	2	3	4	5	6
T1	2.88^{aB}	2.54 ^{abB}	2.28 ^{abcB}	2.02 ^{abcB}	1.87 ^{abcB}	1.56 ^{bcB}	1.28 ^{cB}
T2	3.25 ^{aAB}	3.06 ^{aAB}	2.88 ^{abAB}	2.72 ^{abAB}	2.51 ^{abAB}	2.37 ^{abAB}	1.98 ^{bAB}

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T3	3.92^{aA}	3.71^{abA}	3.41^{abcA}	3.11^{abcA}	2.90^{abcA}	2.71^{bcA}	2.44^{cA}
T4	3.65^{aAB}	3.32^{abAB}	3.02^{abcAB}	2.89^{abcAB}	2.68^{abcAB}	2.48^{bcAB}	2.06^{cAB}

Table 4: Effect of storage period and treatments on Total Phenols (mg/100g) of Bottle gourd juice*

Treat-ments	0	1	2	3	4	5	6
T1	140^{aAB}	126^{abAB}	110^{abcAB}	94^{bcA}	79^{cAB}	67^{cAB}	56^{cA}
T2	150^{aB}	145^{abB}	139^{abcB}	130^{abcA}	119^{bcB}	105^{bcB}	89^{cA}
T3	180^{aA}	176^{abA}	171^{abcA}	165^{bcA}	158^{bcA}	150^{cA}	137^{cA}
T4	160^{aAB}	144^{abAB}	134^{abcAB}	120^{abcA}	103^{bcAB}	94^{cAB}	83^{cA}

Table 5: Effect of storage period and treatments on % Antioxidant activity of Bottle gourd juice*

Treat-ments	0	1	2	3	4	5	6
T1	69.17^{aA}	67.24^{abB}	65.47^{abcB}	64.20^{bcdB}	62.30^{cdB}	60.55^{cdB}	59.35^{dB}
T2	50.33^{aC}	48.59^{abD}	64.32^{abcD}	44.85^{bcdD}	43.30^{cdeD}	41.05^{deD}	39.75^{eD}
T3	73.76^{aA}	72.42^{abA}	70.50^{abcA}	69.35^{abcdA}	68.10^{cdeA}	66.15^{deA}	64.45^{eA}
T4	64.13^{aB}	62.09^{abC}	60.31^{abcC}	58.87^{bcdC}	56.85^{cdeC}	54.80^{deC}	52.75^{eC}

*In all the tables, Data is expressed as means and Values followed by different upper case or lower case letters are significantly different ($p \leq 0.05$) within columns and rows respectively

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